The 2.1 mile long extension of Route 18 between River Road and Interstate 287 provided the "Missing Link" in the New Jersey State Highway System allowing much-needed access to Rutgers University and the Piscataway Township Business Center.

NEW JERSEY Preserving the Past, Preparing for the Future

NEW JERSEY'S ROUTE 18 EXTENSION - THE MISSING LINK

The New Jersey Department of Transportation (NJDOT) faced a daunting set of challenges as it contemplated the Route 18 Extension Project. Dubbed "The Missing Link," the corridor traversed one of the region's most significant archaeological sites, crossed two floodplains and several streams, journeyed through an ecological preserve, and served as a main access point for a university campus and a thriving business district.

Addressing a complex mix of archaeological, historical, environmental, and socio-economic issues while constructing a quality roadway required uncommon vision. Meeting stakeholder expectations hinged on ingenuity, sensitivity, innovation and teamwork.

Thanks to agency coordination and innovative contextual design concepts, NJDOT succeeded in alleviating a major transportation bottleneck with the construction of "The Missing Link" in the New Jersey State Highway System. The project emerged as a sterling example of the Federal Highway Administration's Highways for LIFE principles.

An Abrupt Ending at the River

The current Route 18 had been an important transportation route since the 1700s. The modern road, however, carried more than 40,000 vehicles per day and ended abruptly at New Jersey's Raritan River, causing a severe bottleneck. Plans to extend the roadway had been around for more than 40 years but had been delayed due to issues with funding, alternative alignments and public resistance.

The $82 million project involved a 2.1 mile long extension of Route 18 between River Road and Interstate 287. The extension provided a continuous, four-lane, grade-separated highway with three interchanges, allowing much-needed access to Rutgers University and the Piscataway Township Business Center.

Respecting the Past to Focus on the Future

The 18th century port community of Raritan Landing, a thriving center for local trade at its time, was located directly below the Route 18 Extension area. Some stakeholders held conflicting views about the prospect of construction in this area. On one hand, they saw the need for "The Missing Link," but on the other hand they viewed construction in this historic area as troubling.

As a result, before construction could begin, NJDOT sponsored a $5.8 million data recovery project—the agency's largest single archaeological data recovery effort ever. The work focused on preservation of the Raritan Landing National Register of Historic Places Archaeological District, data recovery of 13 sites within the construction area, and identification of an in-place feature presentation location. The contractor, Slattery Skanska, Inc., had to remove one to five feet of soil in a floodplain area without disturbing artifacts, while simultaneously providing up-to-date information to designers, historic societies and interested members of the public. The tasks represented an enormous volume of work that had to be completed in a compressed timeframe to contain costs.

To complete the recovery efficiently so construction could begin, NJDOT built a team of 40 archaeologists, led by NJDOT Supervisory Archaeologist David Zmoda and Hartgen Archaeological Associates, Inc. Under their strong leadership, the excavation took just five months. A logistical support and construction management team assisted to help maintain the aggressive schedule.

Technology also played a key role in excavating the project site. A state-of-the-art Geographic Information System (GIS) three-dimensional spatial analysis tool never before employed by NJDOT was used to analyze Raritan Landing foundation remains. It allowed designers to locate infrastructure while minimizing the impact to archaeological features and maximizing the preservation of Raritan Landing remains. The team left undisturbed foundation elements that would not be impacted by construction, while using GIS analysis to document foundation areas that would be affected.

With the aid of GIS analysis, the team pinpointed triple the number of foundation remains than previously anticipated. Without this state-of-the-art technology, archaeologists would have had to rely on historical data to map out locations where foundations were presumed to be--a lengthy and pricey method that would have cost the agency precious time and additional resources while it waited to complete the corridor.

Deep foundation drilled shafts were used to minimize the footprint of substructure elements on Metlars Brook. Innovative use of drilled shafts took up only half the area of conventional spread footings, minimizing short-term and long-term environmental impacts on the stream.

An important aspect of the archeological work was keeping the public informed, so NJDOT created its first archeological project website to provide information about the extension project and its archaeological findings. Using GIS, NJDOT made the site interactive, allowing visitors to explore the project area with elements of realism and to study the historic lots and artifacts in real time.

In addition to the website, NJDOT kept most of the excavation area open for public viewing. Schools and other groups could take weekly tours and a local museum displayed many artifacts. In all, crews quickly and carefully excavated more than 78,000 cubic yards of soil that yielded more than one million artifacts. Ultimately, conserving the area's history helped give the public more confidence in the overall construction project.

Inventive Design

The design team employed an array of innovations to resolve specific archaeological and environmental concerns, including drilled shafts, a two-stage retaining wall, retaining wall joint treatments, and the installation of a Vortechnics Stormwater Treatment Unit.

Metlars Brook flowed directly in the path of the project. In an effort to protect the environmentally-sensitive stream, the team used deep foundation drilled shafts to minimize the footprint of substructure elements on the stream. Drilled shafts took up only half the area of conventional spread footings, minimizing short-term and long-term impacts on the waterway. According to NJDOT Project Engineer John McCleerey, "NJDOT has used drilled shafts on several additional projects since the completion of the Route 18 Extension to minimize the impact on streams and the environment. The Department also now uses the technique when footings are located in residential areas in order to reduce the risk of cracking the foundations of older homes."

Near the Raritan River, weak, compressible soil layers located immediately under retaining wall foundations caused design concerns. In order for a retaining wall to be safely constructed in the location, either weak soil had to be removed or new soil preloaded to consolidate earth prior to constructing the retaining wall. However, these options were not viable, as the soil was too thick to remove economically and preloading soil would have an adverse effect on the construction schedule.

The Route 18 team's innovative solution was to construct a standard MSE retaining wall without precast concrete facing…and to do it in two phases. Jim Dziedziak, a Design Engineer with Gannet Fleming, Inc. explained the two-stage retaining wall this way:

> "The soil in the area did not have the properties to hold the foundation of the wall. So the solution was the two-stage retaining wall. First we put soil down behind the wall area, and then built half the wall. This half of the wall sat for six months; its weight squeezed out the excess water in the soil, making the soil stronger. Once the settlement stabilized, facing panels were hung from the first stage portion to complete the wall."

The MSE retaining wall was such a successful innovation that the fabricator has submitted the design for a patent. The process also kept the project on schedule.

When considering the retaining wall, the design team looked for a way to minimize wall construction/expansion joint treatments. On earlier projects,

Taking on the largest single archaeological data recovery project in the Department's history, NJDOT recovered more than one million artifacts prior to the start of construction. Five-by-five foot exploratory excavations were established by archaeology data recovery teams. A team of 40 archaeologists conducted the excavation in just five months.

the most prominent feature of similar walls was not the intended architectural result, but the wall jointing. With the goal of using architectural finishes to achieve an effect of cut stone structures, rather than concrete walls, the designer worked closely with the contractor to, as Dziedziak put it, "soften the joints by eliminating or reducing the size of concrete edge chamfers and by the use of permanent, flexible, stained caulking that was effective in hiding or obscuring the joints." This design element was yet another step in integrating the site into the surrounding landscape.

In a plan to improve water quality structural treatment devices, NJDOT worked closely with the New Jersey Department of Environmental Protection (NJDEP) to implement an innovation system that has now become a standard application on similar projects in New Jersey. To enhance the gravitational separation of the total suspended solids collected in storm water runoff, crews installed a Vortechnics Stormwater Treatment Unit.

The Vortechnics system is constructed of precast concrete and installed below grade, incorporating a series of structures. First come a tangential inlet and a circular grit chamber which direct the discharges through a vortex-like flow path. This action effectively separates settleable and floatable contaminants such as heavy metals, silt and petroleum based liquids from the stormwater. A baffle wall, permanently below the water line, keeps floating pollutants trapped, especially during high flows and cleanout. Flow controls near the outlet allow the treated water to drain slowly. The team rated the new system a significant success, helping make the project a model in dealing with storm water management in New Jersey.

Win-Win Resolutions for Rutgers and Residences

Not only was the Missing Link located in the path of an historic archaeological district and an ecological preserve, but it also ran through the middle of Rutgers University and no fewer than 12 residences.

Coordination with Rutgers was vital since the extension bisected the institution's two main campuses, Bush and Livingston, and served as the main transportation artery for the University. Around 45,000 students each day make their way through the corridor area, and this figure does not include non-university commuters, faculty and staff. As a first measure, crews developed temporary

bus stops, detours, and bus-only access roads to minimize traffic disruption during construction.

Next, Rutgers University worked closely with the Route 18 Extension team to modify its master plan to accommodate the transportation improvements. Two miles of multi-use paths were built to connect the County and University bikeway network. An emergency phone system was installed and connected to the University Safety Office. Overhead sign panels with color-coded destination text were used to direct visitors through Rutgers University campuses. Finally, a roundabout was added at the entrance of the campus to improve safety and enhance the aesthetics of the campus entrance. The alternative to the roundabout would have been a four-way stoplight, which would have slowed traffic at the busy intersection. The roundabout not only allowed landscaping at the official entrance to the University, but proved a more efficient means of moving traffic. It also served as a buffer, making it safer for pedestrians making their way to and from campus.

The resolution for the dozen homeowners whose residences stood directly in the path of the Route 18 Extension emerged as another win-win: NJDOT successfully negotiated the purchase of all 12 homes.

Ecological Challenges and Solutions

A special challenge for NJDOT was to identify methods to preserve and minimize the environmental impact of the Route 18 Extension. This was no easy task as the roadway was located in an area marked by significant ecological constraints. Directly in the path of construction stood two floodplains, the Rutgers Ecological Preserve, and four and a half acres of green parkland. NJDOT teamed with Rutgers University, Piscataway Township and the NJDEP to tackle the diverse issues related to these sites.

A primary NJDOT goal was to mitigate the loss of trees. The solution: an extensive re-forestation plan. Trees within the Rutgers Ecological Preserve were inventoried and salvaged whenever possible. NJDOT also replanted 5,000 trees within the project limits and an additional 5,000 trees throughout the community. Five trees were planted for every one removed. This was well above and beyond the typical mitigation plan of replanting at a 2 to 1 ratio. In addition, NJDOT specified more mature trees to expedite the re-establishment of forested areas. Finally, NJDOT provided $500,000 to an NJDEP fund for other plantings.

An extensive re-forestation plan was needed to mitigate the loss of trees in the area. In addition to salvaging trees whenever possible, NJDOT also replanted 5,000 trees within the project limits and replanted an additional 5,000 trees throughout the community. Two trees were planted for every one tree that needed to be removed.

Floodplains and streams inspired workarounds and design innovations to minimize encroachment and wetland disturbance. Freshwater wetland mitigation was established on-site and additional mitigation was banked with NJDEP at a 2:1 ratio. Because insufficient room existed to create wetlands within the construction zone, NJDEP charged the project a fee in exchange for the wetlands, and used the money to restore and create wetlands in other areas throughout the State.

Finally, enacting a construction moratorium adjacent to the environmentally-sensitive Metlars Brook minimized the impact of construction on local wildlife. The moratorium lasted throughout fish spawning from April to June 30 and deer rut season from July 1 to September 21.

Capturing the Missing Link's Lessons

NJDOT addressed a variety of design and engineering challenges with coordinated and extensive pre-planning, broad consideration of ecological factors and innovative contextual design solutions. Along the way, team members learned many lessons.

McCleerey reports that "careful coordination and pre-planning with Rutgers University went exceptionally well. By including Rutgers in much of the planning phase, the university and NJDOT were able to make adjustments to the design of the project and were even able to add enhancements to meet the needs of the university community."

One lesson learned was that the team felt it may have been a little aggressive in scheduling roadway tie-ins around the university. Plans called for these tie-ins to be completed over separate weekends to minimize disruption to the busy campus, but team members quickly discovered that two days were simply not enough time for the contractor to complete a section of roadway and successfully tie it into existing campus roadways and parking lots. Although traffic was rerouted to complete the tie-ins, Monday morning commuters experienced some inconvenience, especially early in the project. In the future, Dziedziak recommends planning more time for such operations to be completed.

Innovative techniques such as deep foundation drilled shafts and the two-stage retaining wall were keys to success when addressing the environmental factors inherent in the Missing Link. Since using the deep foundation technique to mitigate impacts on the waterway involved in the project, NJDOT has replicated the tactic on other projects where space is too tight to accommodate a conventional footing or where vibrations from conventional footings would cause damage to nearby homes.

The team managed the problem of weak soil with a two-stage retaining wall, constructing half of the wall then giving the soil time to settle before finishing the remainder of the wall. All they while they pressed ahead on other aspects of the corridor. Their solution not only saved money--since the need for new soil was eliminated and weak soil did not need to be removed--but it also allowed the construction of a more structurally-sound retaining wall without further delay to the project.

Despite careful planning, one environmental issue emerged that the team had not foreseen: temperamental soil. Brunswick Shale is a type of soil that can be alternately very soft or rock-hard depending on temperature and rainfall conditions in the area. The construction area was filled with Brunswick Shale, which affected construction plans that called for utility lines to be drilled

underground. At one point, rather than close the roadway for drilling, the team attempted to minimize inconvenience to motorists by using directional drilling. However, Dziedziak explained, "When we tried to use the directional drill, the drill bit was easily sent off course by the Brunswick Shale. This wasn't a problem for the first utility drilling, but as the second and third teams came through to drill for additional lines, the lines would intersect, causing headaches. Looking back, it would have been much easier to just close the road."

NJDOT also learned that no matter how much effort goes into educating the public on road closings and delays, there will be some who do not heed the warnings…a prospect that requires constant vigilance and a strong back-up plan. At one point during the project, a value engineering assessment determined that closing a particular roadway to all truck traffic was more economically feasible than raising a bridge to accommodate truck traffic. Unfortunately, a large number of truck drivers did not follow directions to avoid the area in question, and some trucks became stuck under the bridge. Ultimately, setting up a permanent police presence for six months at the bridge cost nearly $500,000. So about half the money saved by not raising the bridge had to pay for police to turn trucks away.

Finally, NJDOT learned that with sophisticated technology and old-fashioned teamwork, a massive archaeological excavation project--yielding nearly one million items of historical and archaeological value--can progress in a remarkably short period of time. Pivotal to the successful and speedy excavation was the selection of a skilled contractor whose mission was to proceed gently but quickly. With digital mapping and spatial technology to view what was hidden underground, JH Reid Contractors, Inc. worked with archaeologists to excavate 78,000 cubic feet of soil without disturbing precious artifacts. When the $5.8 million data recovery portion of the project ended, these sophisticated methods produced a bonus: the team could share its fascinating findings with the public.

Lessons learned from the project expanded the knowledge and capability of NJDOT, which led a team that preserved the past while building a long-awaited highway improvement. Upon completion, the Route 18 Extension delivered a much-needed missing link in the transportation system serving Piscataway Township and beyond and proved a model of successful partnering between a concerned public and a dedicated team of highway professionals.